Subsurface Imaging with Electromagnetic Induction

Characterizing oil fields, environmental contamination, and underground structures

We are developing a powerful tool that uses audio-frequency electromagnetic radiation and tomographic software for subsurface imaging. Data are collected from two boreholes, where the earth is interrogated between the two holes. The image can be used for site characterization, such as locating bypassed oil deposits or environmental contaminates, or process monitoring, such as tracking a steam flood.

Electromagnetic system

Imaging is based on the fact that electromagnetic signals transmitted underground vary according to the resistivity of the material through which they travel. For example, the resistivity of an oil sand is usually 10 times greater than confining clays, making the oil reserve readily distinguishable from the surrounding rock. In our system, one borehole houses an induction coil transmitter that can be remotely tuned to a variety of frequencies. A receiver for detection, processing, and digital transmission to the surface is lowered into the other hole. An in-field computer is located at the receiver station. High-resolution imaging software has been developed in conjunction with industry.

Benefits

It's estimated that 40% of remaining US oil reserves lie within existing fields, but remain unavailable because of the geological complexity of the reservoirs. Application of improved technology, such as the audio-frequency electromagnetic system, could lead to production of up to 50% of this untapped resource. Also, by applying our technology to environmental site assessment and cleanup, we can reduce time and cost of cleanups by eliminating many of the sampling and monitoring wells through improved knowledge of the subsurface distribution of pollutants and cleaning agents. This technology can also prove useful in military applications to locate underground bunkers or tunnels.

APPLICATIONS

- *Petroleum exploration*
- *Underground environmental restoration*
- *Locating underground structures*

A borehole transmitter is used to locate oil reserves in central California.

Field tests

We have been testing this imaging technology at an oil field in central California and have signed an agreement with an oil-field service company for further developmental work. We have also used it for site assessment prior to underground steam injection for environmental cleanup.

Availability: This technology is available, prototypes have been developed, and field tests are under way. We can work with interested companies to tailor the system to individual applications.

Contact

Michael Wilt
Phone: (510) 422-3152
Fax: (510) 422-3013
E-mail: wilt2@llnl.gov
Mail code: L-156